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# **Storm Damage in Southern India**

**A Preliminary Intelligence Assessment**

~~**Top Secret**~~

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December 1977

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## THE KEY POINTS

- Two major storms late in the cyclone season caused extensive damage in India during November.
- Most of the death and destruction caused by these storms was done by the tidal wave that accompanied the second cyclone that hit the Krishna delta in Andhra Pradesh, leaving at least 2 million homeless and at least 12,000 dead.
- Damage caused by the earlier November storm is less severe but widespread throughout the States of Tamil Nadu, Kerala, and Karataka.
- Damage assessment to the crops on the Krishna delta is continuing. Some of the unharvested rice may be discolored but salvageable. Damage to the rice crop on the large Cauvery - Coleroon river delta of Tamil Nadu (a rice exporting area) caused by the earlier storm is moderate.
- Indian weather officials accurately forecast the occurrence of the cyclones and issued warnings of unexpected changes in course about 24 hours in advance; but there is some indication that the government warnings did not reach the people in the low-lying delta areas.
- Even if earlier warning had been received the density of population, lack of transport, and poor road network would have made any attempted large-scale evacuation difficult.

NOTE: This report was produced by the Office of Geographic and Cartographic Research. Contributions from NPIC and ORPA are incorporated. Comments and questions may be directed to

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## STORM DAMAGE IN SOUTHERN INDIA

This is a preliminary report on the recent cyclone damage in India based on satellite photography and other sources. Photographic coverage to date is limited and spotty because of cloud cover and technical problems. A more comprehensive assessment of damage and recovery progress may be prepared if a need is indicated and the collection difficulties overcome. Appended are notes based on field observations by [REDACTED] an NFAC/OGCR analyst, who was in India on an area familiarization trip at the time of the storms.

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### The Paths of the Storms

A series of major storms late in the cyclone season caused extensive damage to southern India during November. Early in the month, several weak tropical storms and low pressure systems brought above-normal rainfall to the area. On 10 November a tropical cyclone (identified as Number 21-77) with winds in excess of 50 knots was discovered in the Bay of Bengal northeast of Sri Lanka. Moving due west, it struck the coast of India south of Madras on 11 November (map 1), crossed the sub-continent in two days, and passed into the Arabian Sea. The storm reintensified over water and by 17 November had sustained wind speeds of 70 knots with gusts to 85 knots. Turning south and then east it returned to strike the west coast south of Mangalore on 21 November.

On 17 November a second tropical cyclone (22-77) was identified off the east coast. On the 18th, the storm was moving toward the NNW at 7 knots, had sustained winds of 105 knots gusting to 130 knots, and was accompanied by extremely heavy rainfall. After the storm reached land north of Madras, few rainfall and wind data were recorded because weather instruments and communication equipment were destroyed by high winds and flooding.

The second tropical cyclone produced a tidal wave reported to have been 80 kilometers long, 16 kilometers wide and 5.5 meters high with a speed of 104 knots. The tidal wave caused most of the death and destruction in the State of Andhra Pradesh.

### Storm Warnings

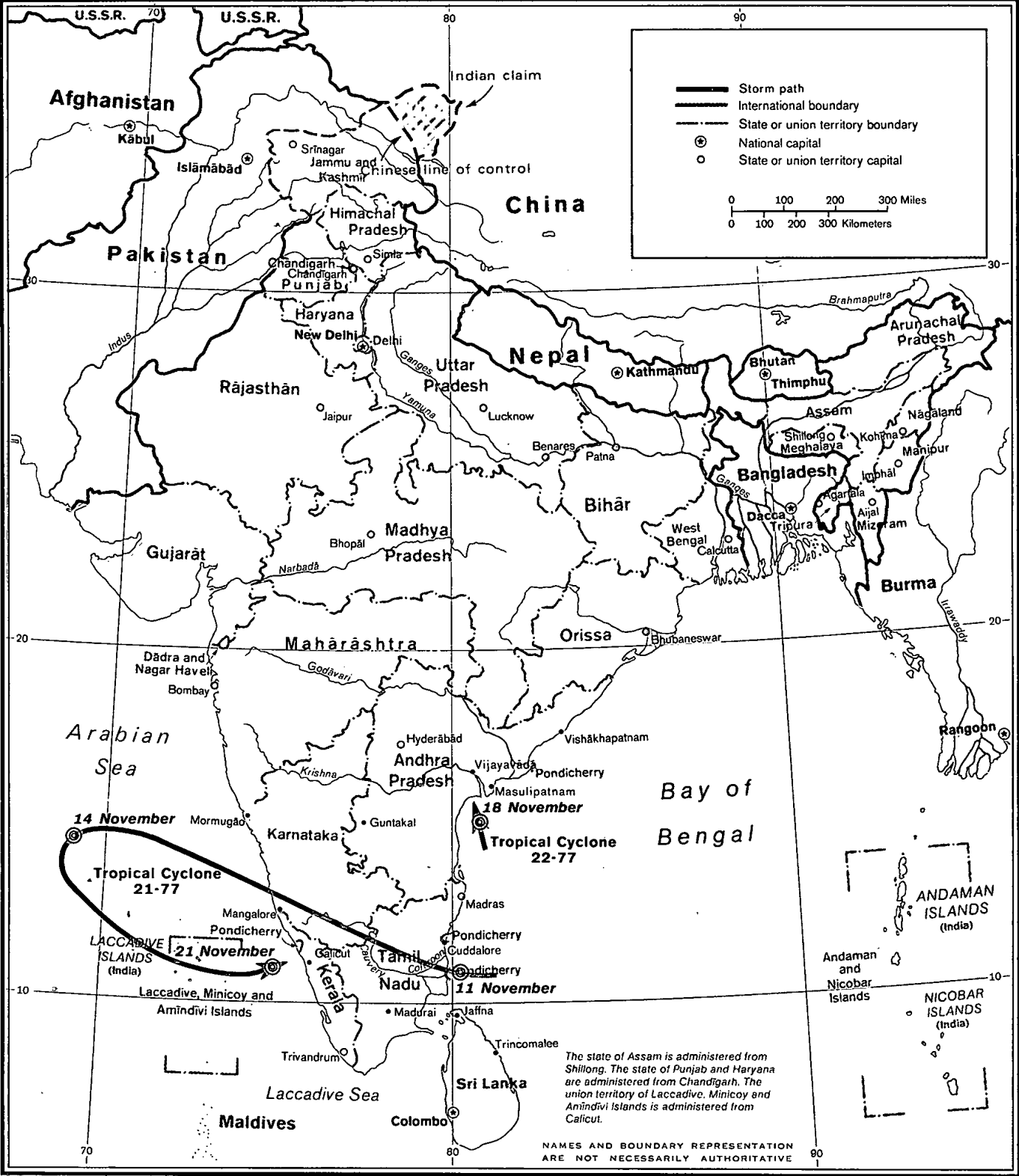
Tropical cyclones are common in the Bay of Bengal in November and loss of life has often been high because of the dense population on the low flats of the river deltas and inadequate procedures for warning and evacuation. For example, in November 1970 a cyclone with a tidal wave struck Bangladesh, then East Pakistan, killing 500,000 people.

The Indian weather officials accurately forecast the path and severity of cyclone 21-77. They also projected the path of cyclone 22-77, saying it would strike the coast of India north of Madras in Tamil Nadu. However, this storm

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Cyclonic Storms Over Southern India



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Map 1

turned suddenly northwestward toward the Krishna (Kristna) delta of Andhra Pradesh. State officials were given about 24 hours warning of the change in course, but may not have warned all the villages.

Cyclone 22-77, which caused the deaths of at least 12,000 people, is described as the worst natural disaster in the Krishna delta since 1864 when 35,000 people died in a tidal wave.

The Damaged Area: Andhra Pradesh

Tropical cyclone 22-77 hit Andhra Pradesh hardest in the coastal districts of Krishna and Guntur, which cover the small peninsula formed by the Krishna River delta and have a total population of more than 5 million people (map 2).

This lowland is predominately agricultural and the population is dense. According to the most recent available data, the two districts had population densities of more than 250 people per square kilometer, and about 65 percent of the labor force were farmers and agricultural laborers. The delta population lives mainly in scattered rural villages of 1,000 to 5,000 inhabitants. The fishing villages along the coast are smaller. The delta towns of Masulipatnam and Tenali each had over 100,000 residents, and Guntur and Vijayavada each had about 200,000.

The fertile, irrigated Krishna River delta is mainly in paddy rice cultivation with some commercial crops -- Virginia leaf tobacco, cotton, jute, and seasoning. The local industry consists of agricultural processing such as hand looming of cotton, jute and sugar cane mills, and tobacco warehouses.

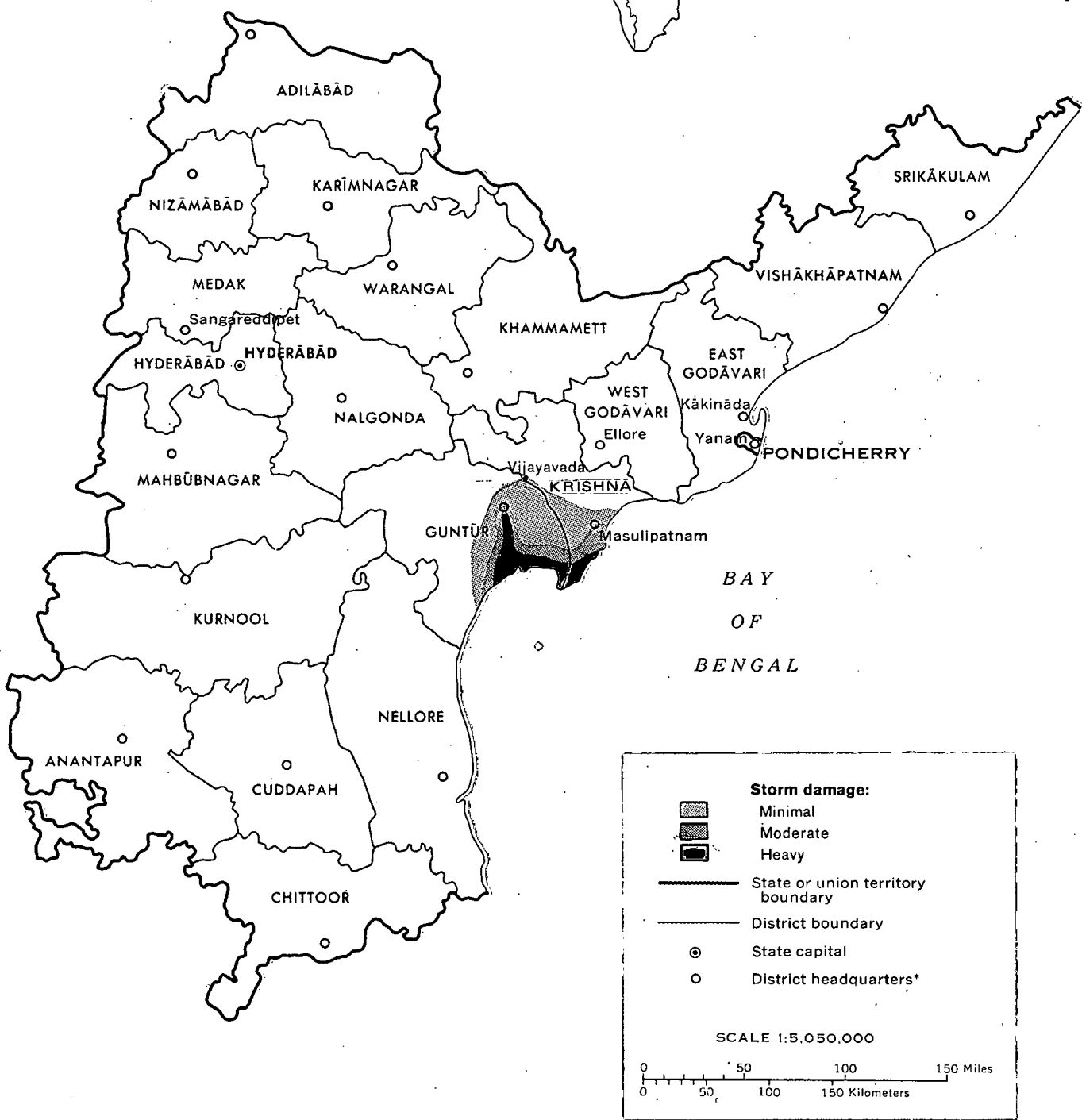
Damage Assessment

Map 2 shows the extent of the cyclone damage, most of which is concentrated in the coastal portions of Guntur and Krishna districts, where

more than 125 villages destroyed or heavily damaged. The typical village home in this area has a thatched roof and mud walls that tend to dissolve quickly when submerged by rising waters. Reportedly, 21 villages were totally destroyed by the storm tides. The few standing buildings, built of stone or concrete block, probably have weakened walls and roofs, missing windows and doors, and deeply silted floors. Photographs 1 and 2 show this type of village destruction.

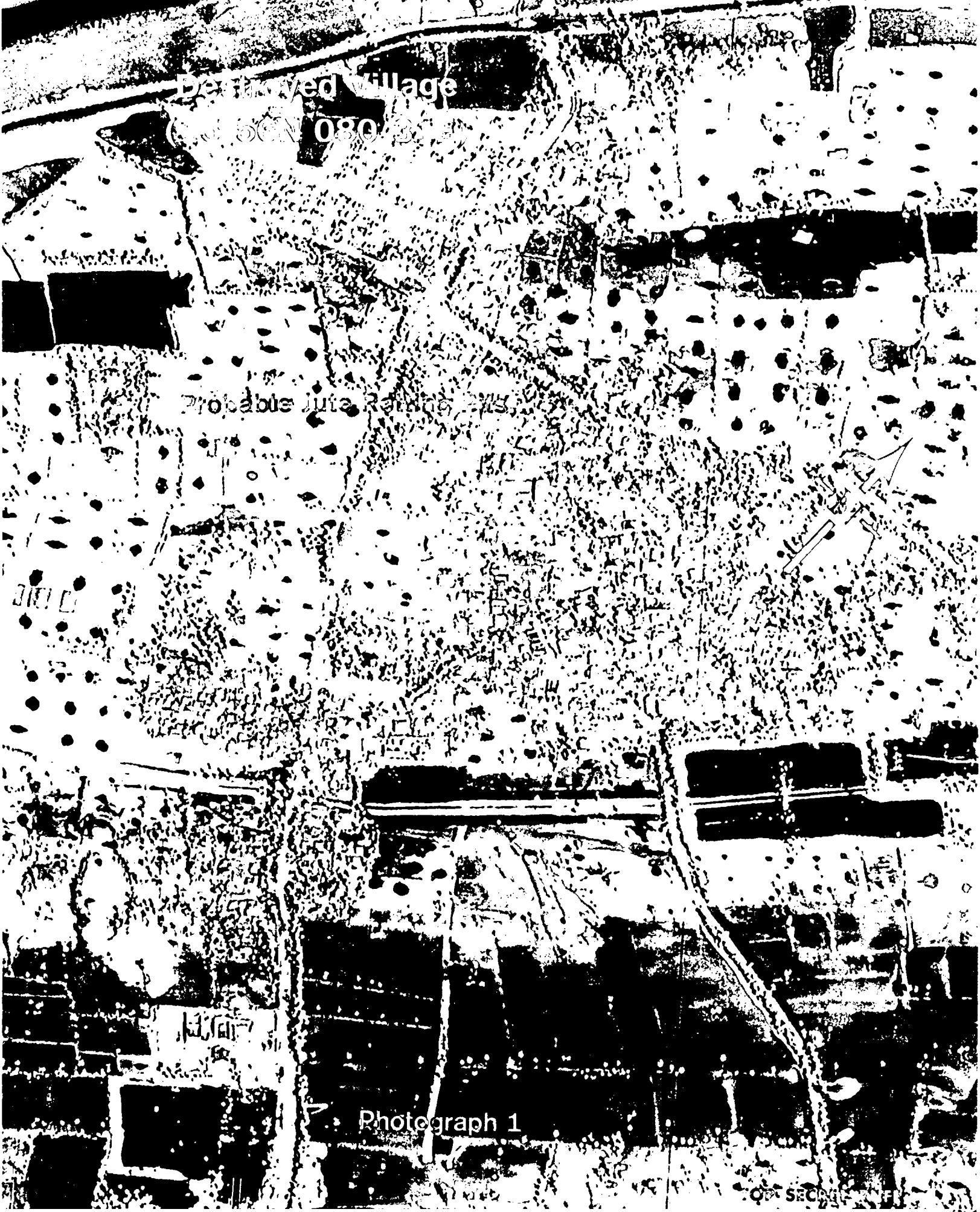
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# Storm Damage in Andhra Pradesh

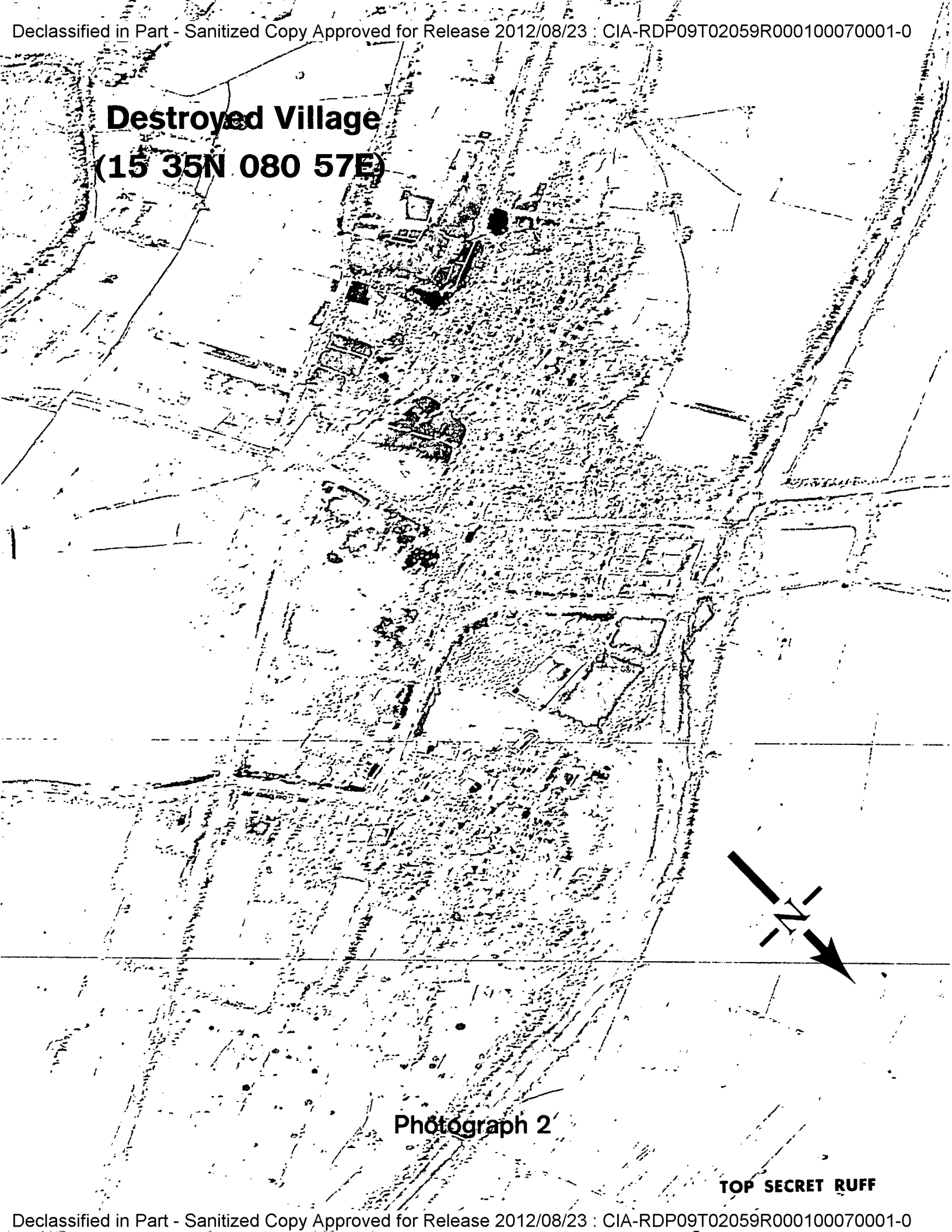


*\*When district headquarters are not named they have the same name as the district.*





**Destroyed Village**  
**(15 35N 080 57E)**



**Photograph 2**

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Official reports from the area estimate that more than 10,000 people were killed and 4,000 are missing, with half of these presumed dead, and 2 million are homeless.

There has been heavy damage to power and telephone lines, roads, and waterways. The district capital of Guntur received damage in its southern suburbs and to its agricultural warehouses (photograph 3). Irrigation canals suffered external damage. Photographs of Vijayavada, in Krishna district shows canal repairs under way (photo 4).

The crop status will take several weeks to determine. Observers are concerned about waterlogging of the paddy rice still in the fields. Much of the unharvested rice may be discolored by flood water (and receive a lower price) but could be salvaged. Much of the agricultural produce stored in warehouses may have been soaked and lost. Indian officials now estimate that the crop loss will be 10 billion US dollars; US embassy officials believe a more realistic figure would be 2.5 billion US dollars. In addition to the crop losses are the livestock destroyed -- 250,000 cattle and 700,000 other farm animals.

#### Relief Efforts

Three weeks after the storm there is no photographic evidence of major relief activities, but access into the area does not appear to be a problem in starting the relief effort. Map 3 shows that the major roads, railroads, and airfields in the state are usable; however, small areas could still be isolated.

The Government of India has given the army the primary responsibility for relief efforts, and the following priorities have been set: 1) dispose of the dead bodies and carcasses by burning or burying them; 2) give mass inoculations for cholera and typhoid; 3) disinfect wells, tanks, and waterlogged areas around villages; 4) provide drinking water; 5) supply medicine and clothing to refugees; and 6) clear debris and restore broken communications.

The Government of Andhra Pradesh reported on 29 November that 200,000 people of the 2 million homeless had been given shelter in 200 centers, probably schools. (These centers have not yet been identified on photography.) The army has been asked to construct concrete or brick shelters for better protection against future cyclones, but this is unlikely to occur because of the cost involved.

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**Gunter (16 18N 080 26E)**

**Damaged Agriculture Warehouses**



**Photograph 3**

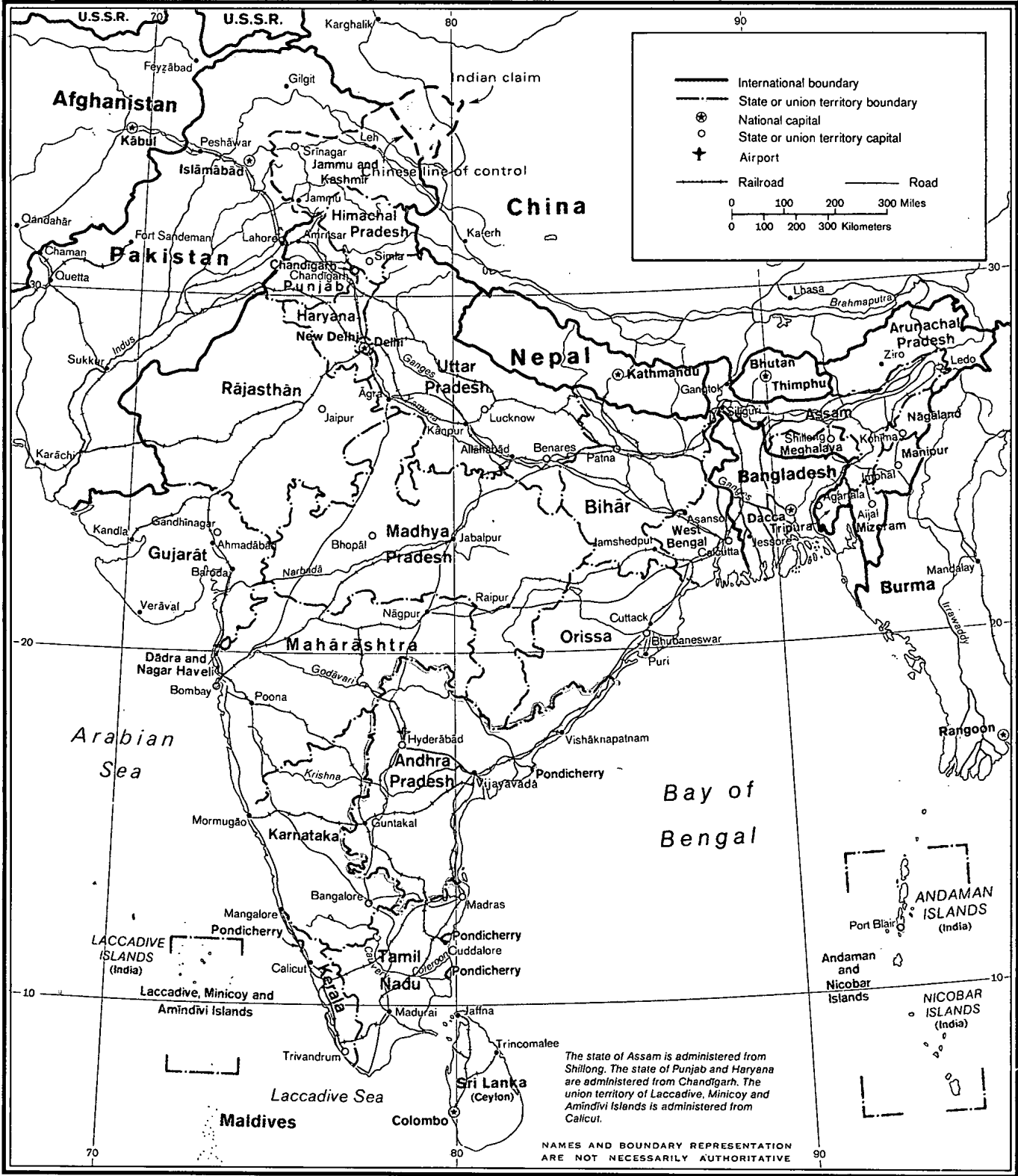
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Photograph 4

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Major Transportation Links to Andhra Pradesh



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Map 3

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The political situation in Andhra Pradesh may be largely responsible for inadequate relief efforts thus far. The state government, controlled by the Congress Party, is at odds with the Janata Party administration in New Delhi. This may account for difficulties in coordinating and implementing a relief program. At the same time, the Andhra Pradesh Government faces state elections next spring and presumably wants to enhance its public image by performing well in relief efforts.

The Janata Party has been sharply critical of Andhra Pradesh's relief measures, and the central government has the power to dismiss the state government and impose "emergency rule" from New Delhi. The threat of dismissal, coupled with factional problems within the Congress Party that led to the resignation of several state cabinet ministers shortly after the cyclone, may have seriously affected the government's ability to respond quickly and thoroughly to the needs of the survivors.

#### Damage in Tamil Nadu

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Cyclone 21-77, which struck Tamil Nadu on 11 November, caused fewer deaths and less property damage than cyclone 22-77 did to the north, but its destruction covered a wider area -- the coast area and pockets as much as 150 kilometers inland. Much of the coastal damage, caused by the high winds and heavy rains, was on the large delta formed by the convergence of the Cauvery and Coleroon River systems. Inland, heavy rains resulting in local flooding caused much of the destruction. In Madurai district a newly built dam broke under the flood waters and inundated 46 downstream villages.

More than 2,000 are dead (official lists report 400) and at least 317,000 are homeless in Tamil Nadu. Damage to more than 350,000 houses, downed power and telephone lines, and ruined crops and lost livestock are valued at 130 million US dollars, according to US embassy reports. The Chief Minister has ordered an official inquiry into the cause of the dam's collapse. Relief efforts are progressing well. The first phase -- rescuing the marooned, feeding and sheltering the homeless, restoring main public transport and utilities -- is complete. The second phase, now under way, is the distribution of money and utensils because food markets have returned to normal.

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Damage in Kerala, Karnataka, and Kalpeni Island

Cyclone 21-77 returned on 21 November to penetrate inland along the western coast of India. There is no available satellite coverage of this area, and field reports are incomplete for these two states.

Kerala officials have reported 80 dead and 62 missing. The revenue minister, calling the storm the worst the state had suffered in 30 years, has asked the Government of India for 50 million US dollars' worth of outside assistance.

Newspaper accounts describe the destruction of Kalpeni Island. One-fourth of its homes have been razed, and most of the island's coconut palms are heavily damaged.

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## Appendix

## Field Observations by

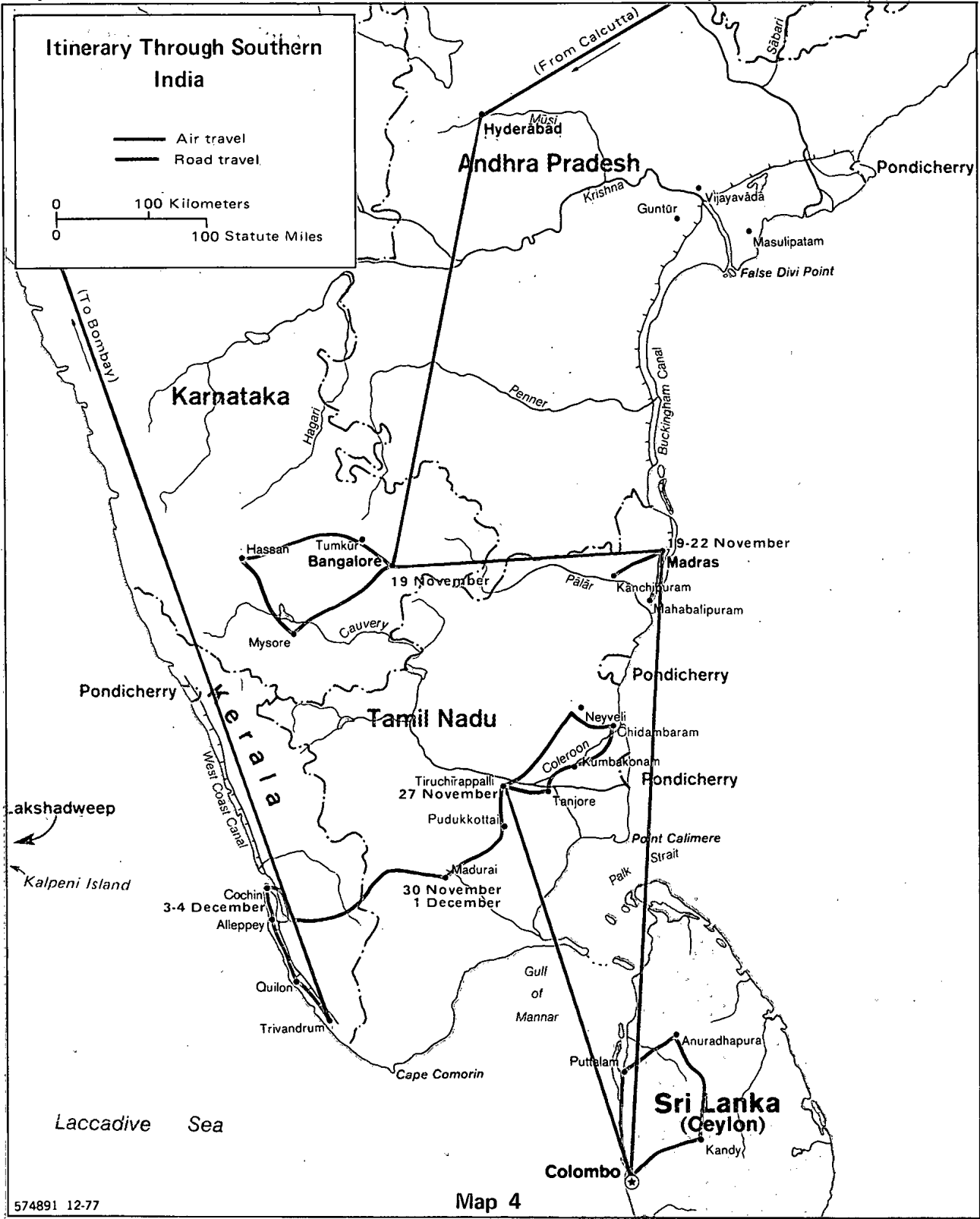
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During the recent cyclones I was traveling with a tour group through eastern and southern India (map 4). The group was well aware of the passage of these storms, both before they hit the coast, through altered flight schedules, and afterwards via ground travel conditions in Tamil Nadu.

## First Storm (11-12 November)

Storm warnings first reached us in Puri on the Orissa coast on 11 November. We were scheduled to fly from nearby Bhubaneswar to Hyderabad, changing planes at Vizakhapatnam. I had been looking forward to the flight in and out of "Vizak" as an opportunity to get an overall view of the new harbor development, but the flight was canceled due to expected "bad weather conditions." We were consequently bundled into a railway car on the night train to Calcutta for a flight the next morning to Hyderabad. Upon arrival we learned that a cyclonic storm had struck the coast south of Madras on 11-12 November.

A little more than a week later on the 20th and 21st of November we made two day-trips from Madras, the first south along the coast road to Mahabalipuram, and the second southwest of Madras to Konchipuram. Parts of fields were flooded and flood damage was very evident. Much of this flooding could have been due to the heavy rains associated with the passage offshore of the 19-20 November cyclone, which only brushed this region and hit the coast 200 miles (320 kilometers) to the north of Madras, which had expected -- but failed to receive -- the onslaught of the earlier storm. The rain from the second storm, sometimes quite heavy, did not stop until mid-morning of the 20th. Several small bridges on the coastal road had been badly damaged and temporary by-passes erected. Bunds around rice paddies had been breached in places and the necessary repairs not yet made. At any time inspection and repair to these low mud retaining walls is a daily chore because of leaks caused by burrowing land crabs.



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Women were spreading rice in thin-layered patches on one side of the pavement. I questioned our local guide about this practice, which seemed a bit odd with wheeled traffic moving within inches of the carefully spread kernels. The guide explained that stored rice had gotten wet during "the recent storm" and if allowed to sprout would be ruined. The pavement offered the only flat, dry surface to sun-dry the rice. There appeared to be little other visible storm damage.

The after effects of the 11-12 November storm were also observed in the vicinity of Tiruchirapalli and across the Cauvery delta in Thanjavur (Tanjore) District in two bus trips on 28-30 November. "Trichy" is located at the apex of the Cauvery delta approximately 90 miles (150 kilometers) inland from the coast. The streets, although paved, were muddy, with many puddles. The mud was deposited during the 11-12 November storm but the puddles were probably associated with the weather at the time of our visit -- intermittent drizzle and heavy rains associated with the offshore passage of a third storm that never rose above the category of severe tropical disturbance.

In the central part of the city near the base of the Rock Fort is a large tank (man-made lake) fed by one of the Cauvery distributaries. Facing the tank is a large Christian cathedral. Water marks were plainly visible over the main doorway about 12-13 feet (4 meters) above ground level. Local people assured us that the high water was the result of a "tidal wave." I found this explanation difficult to accept at this distance inland. Persistent questioning revealed a more plausible explanation. As the 11-12 November storm moved inland, the heavy rain upstream caused the rivers to rise rapidly to super-flood levels. A survey of the surrounding terrain from a vantage point atop the Rock Fort tended to confirm this judgment.

Two other observations lend credence to this view. Subsequent bus travel along two different routes crossing the delta to the east, seaward of Trichy, revealed no evidence of recent tidal wave damage. Rice fields were undamaged and in apparent good condition. This is one of the heavy surplus rice producing areas in India. HYV rice with characteristic short stalks accounts for almost all of the rice planted in this delta region. Crops were in all stages of growth. Even in mature fields I saw no evidence of lodging. The harvest of the summer rice crop was in full swing, and mounding of freshly cut stalks, threshing, winnowing, and rice-drying operations were conducted on one

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side or the other of the pavement of the main Trichy-Madras highway, making the road one-way in stretches. According to our new guide, it was standard practice and not due to field conditions -- just lack of other space in the crowded delta.

East of the Thanjavur city there was evidence of wind damage in the banana groves. Banana trees were bent over or snapped off, and many groves looked completely gutted. The main roads are lined with trees of various species, particularly neem and tamarind. Some of the tamarinds were uprooted and those not actually blocking the road were still lying where they had fallen. The tamarind is an impressive tree with a large trunk, and although not tall, has a wide, heavily branched canopy. Fallen it looks top-heavy compared to its root structure. There is no tap root. The tree sends out many shallow lateral roots, and thus older trees are especially vulnerable to wind damage. All these trees are numbered consecutively and felling is forbidden. Clearing requires a certain amount of local bureaucratic paperwork. Some top damage to palms was also noted. I also saw a large heavy metal sign about 4'x6', mounted on the roof of a one-story building, the top corner and one side of which was bent over as if it were a dog-eared page in a book. Obviously done with great force.

Evidence of heavy rains was observed along the main highway west of Trichy via Madurai on 30 November. Damage to a bridge between Trichy and Madurai forced the bus to take an alternate route. The going was slow, particularly at creek crossings. This road had "Irish bridges" -- down-and-ups, the British on the tour called them -- a paved ford across a creek bottom that at periods of high water may be water covered, but normally allows the stream to cross under the paved surface via culverts or pipes. These bridges were slithery with mud, and the banks of the smaller streams showed evidence of recent scouring. In Padukkotai while at the local Government Rest House for tea and a "loo" stop, I saw several men at the far end to the yard painting a red line on a white post. The post was to be erected at the bridge just outside of town to show a new record high-water mark that looked to be about 1 1/2 to 2 feet (0.5 to 0.7 meters) above previous high levels. Although the language barrier (limited and heavily accented (Indian-English) made complete understanding difficult, I gathered that this was the new high-level mark at the bridge attributable to the storm of 11-12 November.

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On the plane trip from Colombo to Trichy on 27 November I was sitting next to a man reading a copy of The Hindu, an Indian English-language newspaper. An article datelined Kalpeni in Lakshadweep caught my eye. It described the destruction on the island from the storm of 20 November, "the worst in the island's history." The island had been awash knee-deep. There was minimum loss of life, but extensive property damage to buildings on the island. The entire current crop of coconuts stored in mounds on the ground was swept away and many of the coconut trees uprooted. Apparently the 11-12 November storm crossed the peninsula as a heavy rain storm, blew out over the Arabian Sea, picked up momentum, looped back toward the coast striking Kalpeni before crossing the west coast of the sub-continent. In Kerala from Cochin south to Trivandrum no storm damage was evident and local people said that the storm did not pass that way.

#### Second Storm (19-20 November)

The cyclone which slammed into the Krishna River delta in Andhra Pradesh the night of 19-20 November with winds over 100 knots was compared in severity in the Indian press with the holocaust that hit the Ganga delt in Bangladesh on 13 November 1970, killing upwards of 500,000 people. Loss of life in the Krishna delta, particularly in Guntur District, was estimated to be 9,000 to 10,000 at that time, but many more thousands were left homeless and destitute. The lethal element in both of these storms was a tidal wave or waves, a wall of water that rolled over the low-lying coastal areas destroying the flimsy, mud brick and thatch-roofed huts in its path. Periodic reports of the locations of the storm centers and their likely paths reached major urban areas, but failed in some cases to be relayed to the more remote villages near the coast.

Indian newspapers for the next three weeks contained many featured articles about the extent of local damage and the need for emergency clean-up funds (hopefully from Delhi), and donation appeals for flood relief were made on billboards seen in Bombay on 10-13 December.

Fortunately, I missed most of 19-20 November storm. Our group was well aware of the approaching cyclone. We were in limbo awaiting departure for Madras after passing through security at Bangalore airport. The sky was overcast and ominous, more so when one had knowledge of the storm's approach. Our flight was periodically delayed "due to bad weather in

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Madras." Some members of the group, understandably upset and nervous, did not want to fly at all. The "s-s-h-hedule" of the tour group prevailed. Our arrival in Madras in early evening was wet but uneventful. The air-conditioning system in the hotel was so noisy and the heavy draperies designed to keep out heat so sound-deadening that most people slept through the height of the storm that by-passed Madras close to midnight, bringing only high winds and heavy rains.

Keyed to the time of the departure of the plane and from scuttlebutt in the airport lounge, until late afternoon on the 19th the Indians expected the storm to hit the Madras area. With only 6 to 8 hours' warning of a more northerly trajectory, I don't see how any evacuation of coastal areas in the Krishna delta could have been accomplished. The road system is poor, transportation limited, there was no time to bring in additional vehicles, and nowhere to climb up and away from high water in the flat delta even with forewarning.

































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